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ABSTRACT

WISC (Wechsler Intelligence Scale for Children) and WRAT (Wide Range Achievement Test) data from the first sample of 60 children with uncomplicated meningomyelocele (a neurological condition) were examined to determine their deviation from test norms. A second sample of 46 children was tested with the WISC-R, WRAT, VMI (Visual Motor Integration) memory scales of the DTLA (Detroit Test of Learning Aptitude) and the Achenbach Child Behavior Checklist. Results supported previous reports of differences in overall level of cognitive abilities of children with meningomyelocele when compared to "normal" children. Individuals with meningomyelocele tended to score below established norms on the WISC, WISC-R, WRAT, VMI, and auditory memory scales of the DTLA. Findings were not related to presence or absence of shunt. In the absence of shunting, functional motor level was inversely related to WISC IQ. All Achenbach Scales except School Competence were within normal limits. Standard deviations tended to be greater in these populations than in established norms. These studies emphasize the need for comprehensive evaluation of individuals' pattern of strengths and weaknesses in planning children's remediation programs as well as in facilitating compensation for fixed deficits in older individuals. (Author/CL)

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Cognitive Skills of Children with Meningomyelocele

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ABSTRACT

WISC and WRAT test data from the first sample of 60 children with uncomplicated meningomyelocele were examined to determine their deviation from test norms. A second sample of 46 children was tested with the WISC-R, WRAT, VMI, memory scales of the DTLA, and the Achenbach Child Behavior Checklist. The additional measures permitted more precise assessment of perceptual-motor, memory, and behavior patterns in this sample. Individuals with CNS infection or bleeding were excluded and all were grouped by functional motor level.

The results of this study support previous reports of differences in overall level of cognitive abilities of children with meningomyelocele when compared to "normal" children. Individuals with meningomyelocele tended to score below established norms on the

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WISC, WISC-R, WRAT, VMI, and auditory memory scales of the DTLA. These findings were not related to presence or absence of shunt. In the absence of shunting, functional motor level was inversely related to WISC IQ. All Achenbach Scales except School Competence were within normal limits. Standard deviations tended to be greater in these populations than in established norms. These studies accentuate the real need for comprehensive evaluation of any individual's pattern of strengths and weaknesses in planning remediation programs in children as well as in facilitating compensation for fixed deficits in older individuals.

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Advances during the 1950s in the surgical intervention for hydrocephalus, i.e., shunting, resulted in significantly increased survival rates of children born with meningomyelocele (McLone, 1982; O'Brien & McLanahan, 1981; Shurtleff, 1980). Further advances in the 1970s improved the quality of outcome. As ever-increasing numbers of these individuals enter the school system and reach young adulthood, the need is accentuated for more information about what has been termed a "new disease" (Leonard & Freeman, 1981). Yet the research to date on this population is difficult to compare and contrast for the following reasons.

Modern medical and surgical treatments, aided by noninvasive diagnostic tools such as computerized axial tomography and ultrasound, as well as prenatal diagnosis, have led to far fewer complications of shunting procedures. For example, significant reductions in the number of complications due to infection of the shunt (McCullough, Kane, Proper, & Wells, 1980; Venes, 1976) have been reported. This is important because intellectual deficits associated with central nervous system (CNS) infection and bleeding as complications of shunts have been described (McLone, Czyzewski, Raimondi, & Sommers, 1982; Shurtleff, Foltz, & Loeser, 1973; Venes, 1980).

A second reason is that existing literature on meningomyelocele describes heterogeneous samples. For example, children with hydrocephalus without meningomyelocele have been included indiscriminately with groups of children with hydrocephalus with meningomyelocele (Andrews & Elkins, 1981; Connell & McConnel, 1981;

Ingram & Naughton, 1962; Lonton, 1979; Tew & Laurence, 1975).

Next, different procedures have been used to form groups of subjects with meningomyelocele. These have included functional motor level (Badell-Ribera et al., 1966; Shurtleff, Hayden, Chapman, Broy, & Hill, 1975), sensory level of lesion (Soare & Raimondi, 1977), and type or anatomic placement of lesion (Laurence & Tew, 1971; Raimondi & Soare, 1974).

Another contributing factor to the lack of clarity in this area is the use of a multiplicity of assessment instruments that are not directly comparable. For example, intrastudy comparisons have assumed equivalence of the Stanford-Binet and Wechsler Scales (Shurtleff et al., 1975).

Despite these flaws in the research, some findings seem to persist. Unshunted hydrocephalus has a deleterious effect (Badell-Ribera, Shulman, & Paddock, 1966; Foltz & Shurtleff, 1963). Children with surgically treated hydrocephalus scored significantly lower on IQ compared to their siblings (87.7 and 109.5, respectively, Soare & Raimondi, 1977). Shunted meningomyelocele patients compared adversely to meningomyelocele patients without symptomatic hydrocephalus (70 vs 90 in Tew & Laurence, 1975; 87.7 vs. 102.3 in Soare & RAimondi, 1977). However, when CNS infection was excluded both nonshunted (IQ = 102) and shunted (IQ = 95) children were within the average range (McLone et al., 1982).

The two studies of this report were designed with these problems in mind, and the children were selected so that the previously

mentioned problems in the extant literature were kept to a minimum. Children with CNS complications were not included, diagnostically homogeneous groups were formed, a standard grouping was done via functional motor level, and only one intelligence and one achievement test were used, allowing for individual subtest and academic skills to be assessed in a reliable fashion. The children in the first sample had benefited from the surgical advances in the 1950s, e.g., shunting procedures. Hence, they serve as a good comparison group to children in prior studies as well as to ongoing research with children who have further benefited from the advances made in the 1970s, e.g., improved shunting and diagnostic techniques. This is the second sample.

METHOD

Sample 1

The first sample is 60 children tested with the WISC and the WRAT between 1967 and 1974. All had meningomyelocele and any with a history of CNS infection or bleeding were excluded. Parents approximated WISC standardization sample closely in occupation level. 57% of this sample were female and 42% had a shunt. They were grouped by functional motor level, i.e., L2, L3-5, S1 (from Shurtleff et al., 1975).

Sample 2

The second sample is 46 children tested with the WISC-R, WRAT, VMI, memory scales of the DTLA, and the Achenbach Child Behavior

Checklist. Inclusion of these additional measures allowed us to assess more precisely the perceptual-motor, memory, and behavior patterns in this sample. These children were similar to those in Sample 1 in sex distribution (51% female) and parental employment level. Again, all with CNS infection or bleeding were excluded, and they were grouped by functional motor level.

RESULTS

The initial analyses focused on determining the similarity of these samples' scores on the individual subtests of the WISC and of the WISC-R to the actual test norms (M IQ = 100; M subtest score = 10). The t test for a difference between a sample mean and the population mean was utilized. As is noted in Table 1, differences on the first sample were seen on Performance IQ, Full Scale IQ, and on every subtest except five, i.e., Information, Comprehension, Similarities, Vocabulary, and Picture Arrangement. On the second sample only the Similarities subtest was not significantly different from the actual test norms.

The next series of analyses involved a 2 X 3 ANOVA with between group effects for two shunt categories (shunt vs. no shunt) and three levels of functional motor activity (L2, L3-5, and S1). The Duncan Multiple Range Test was used to further elaborate differences reported at the .01 level of significance. Table 2 records these results. For the first sample, significant main effects for functional motor

activity were obtained for Performance IQ and Full Scale IQ with the L2 group obtaining lower socres than the other two groups. For the second sample no main effects were significant. There were no significant main effects of shunt for either group.

In the first study, significant interaction effects were obtained for Performance IQ and Full Scale IQ as well as for Information, Picture Arrangement, and Block Design subtests. In children without shunts, scores were inversely related to severity of motor loss with L3-5 and S1 children obtaining scores within the average range. In contrast, motor level functioning had no predictive power in children with shunts and only the L3-5 group was within the average range. This was not found in the second group.

A potentially more useful and empirically more relevant method of analyzing WISC scores is to examine the three WISC/WISC-R factors as outlined by Kaufman (1979). These are Verbal Comprehension Abilities (VCA), Perceptual Organization Abilities (POA), and Freedom from Distractibility (FFD). As is apparent in Table 3, the first sample of children differed significantly from the norms of POA and FFD but not on VCA. With the second sample, all Kaufman factors were significantly below the norms.

Using the 2 X 3 ANOVA, significant main effects for motor level was obtained for all of these Kaufman factors in study 1. Children in the L2 group scored lower than each of the other groups on all factors. In study 2, no significant main effects for motor level were found. No main effects of shunt were noted for either sample. An

interaction between shunt and motor level was seen only on POA and only with sample 1. In the absence of shunting with this group, motor loss was inversely related to the POA score, whereas for children with shunts, motor level was not predictive of the POA score.

Performance on the WRAT was compared to actual test norms (Jastak & Jastak, 1965). Scores for sample 1 were significantly lower than the published norms for spelling ($M=88.8$; $t=-4.138$, $p<.001$) and arithmetic ($M=85.5$; $t=-7.925$, $p<.001$) but not for reading ($M=96.8$). For sample 2, the score for arithmetic ($M=92.0$; $t=2.631$, $p<.01$) was below published norms but the scores for spelling ($M=97$) and reading ($M=97.4$) were not.

Standard scores on the VMI and DTLA were examined for children in the second study. Standard scores were derived by the usual formula of dividing the mental age by the chronological age and multiplying by 100. The mean score for the VMI was 69.5, for the DTLA Unrelated Words was 69.4, and for the DTLA Related Syllables was 79.6. This further documents the perceptual motor and memory deficits in individuals with meningomyelocele.

Several factors were scored from the Achenbach Revised Child Behavior Checklist. The results indicate that this sample was within normal limits on all Achenbach Scales except for School Competence, an expected finding given the frequency of special class assignment in this sample. Interestingly, Internalizing was significantly correlated with PIQ, POA, and FFD. The same pattern was associated with Externalizing, with fewer behavior problems related to higher

intelligence on these measures.

The two groups did differ significantly from each other ($p<.01$) on VIQ, PIQ, and FSIQ. However, the absolute differences were within the expected WISC/WISC-R difference range reported by Sattler (8 points lower on WISC-R with low average samples).

DISCUSSION

The results of this study, with two samples of uncomplicated meningomyelocele children, support previous reports of differences in overall level of cognitive abilities of children with meningomyelocele when compared to normal children. Individuals with meningomyelocele tended to score below established norms on the WISC, WISC-R, WRAT, VMI, and auditory memory scales of the DTLA. In contrast to previous research, these findings were not related to presence or absence of shunt. In the absence of shunting, functional motor level was inversely related to WISC IQ. All Achenbach Scales except School Competence were within normal limits.

The goal of this analysis is not to create a profile typical of individuals with meningomyelocele with or without shunted hydrocephalus. Any such profile has the potential to be misleading in that the standard deviations of scores tended to be greater in these populations than in established norms. Rather the goal of these studies is to accentuate the real need for a comprehensive evaluation of any individual's pattern of strengths and weaknesses. This need is

apparent in academic settings as well as in counseling and preparation for employment. Knowledge of differences on the more specific subtests increases the probability of more realistic and more carefully tailored remediation programs for these children in educational settings.

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Table 1.

Comparisons of the Total Samples to the WISC/WISC-R Norms

	WISC Mean	WISC-R Mean	WISC P*	WISC-R P
Intelligence scores				
Verbal IQ	95.6	85.7	nsd	.001
Performance IQ	89.4	85.3	.001	.001
Full Scale IQ	92.0	85.5	.001	.001
Subtest Scores				
Information	8.9	8.2	nsd	.005
Comprehension	9.0	7.3	nsd	.001
Arithmetic	8.3	8.1	.001	.001
Similarities	10.0	8.5	nsd	nsd
Vocabulary	9.8	7.7	nsd	.001
Digit Span	8.9	8.0	.005	.001
Picture Completion	9.8	8.2	nsd	.001
Picture Arrangement	8.3	8.3	.001	.001
Block Design	8.5	8.2	.005	.005
Object Assembly	8.9	8.3	.005	.005
Coding	6.9	6.1	.001	.001
Mazes		7.1		.001

*nsd, no significant difference.

Table 2.

Comparison of WISC and WISC-R Mean IQ Scores by Functional Motor Level

	WISC				WISC-R		
IQ	L2	L3-5	S1	IQ	L2	L3-5	S1
Verbal	84.7	100.0	94.3		72.4	84.8	95.5
Performance	75.9	93.8	91.1		75.1	86.4	90.3
Full Scale	78.6	96.8	92.5		75.1	85.2	92.6

Table 3.

Mean Scores for the Total Samples on

Kaufman WISC/WISC-R Factors

Factors*	WISC	WISC-R
VCA	9.6	7.9
POA	8.9	8.3
FFD	8.0	7.4

*VCA = Verbal Comprehension Abilities;

POA = Perceptual Organization Abilities;

FFD = Freedom from Distractibility.

Table 4.

Mean T scores on the Achenbach

Child Behavior Checklist

Achenbach factors	Mean	S.D.
Total Internalizing T Score	58.1	9.9
Total Externalizing T Score	56.3	9.7
Social T Score	43.2	11.2
School T Score	34.3	11.4
Activities T Score	43.6	8.6

Footnote

L2 indicates that the lesion is at or above the second lumbar vertebra. All thoracic and lumbar root levels 1 and 2 intercostal, abdominal and hip flexion and adduction muscles function and essentially all of these patients are wheelchair-bound.

L 3-5 indicates that the lesions are between the third and fifth lumbar vertebra. Additional muscle strength in the quadriceps and hamstrings give stronger hip flexion and adduction with knee flexion (weak) and extension; some patients have anterior tibialis with weak foot dorsiflexion and weak hip abductors; most walk effectively with aids, surgical operation, and extensive bracing.

S1 indicates lesions at or below the first sacral vertebra. There is an additional muscle strength about the ankle with variable degrees of hip abduction and extension. Essentially all of these children walk with minimal aids.

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